Air Quality Monitoring

The Neighbourhood of Calder, Edmonton

Winter, summer 2004 and winter 2005 **Final Report**

Introduction

A Canadian National (CN) rail yard is located just south of the neighbourhood of Calder, in Edmonton. The yard handles on average 50 trains daily and operates 24 hours a day, throughout the year. Residence of Calder neighbourhood had concerns with diesel fume impacts on the air quality in the area, especially from trains that are left to idle for extended periods of time. To assess the quality of air in the Calder neighbourhood, Alberta Environment conducted mobile air monitoring surveys in the winter and summer of 2004 and the winter of 2005. The surveys were conducted on days with light wind. Monitoring locations were selected such that samples were collected upwind and downwind of the Calder yard. The surveys were unannounced and used the department's Mobile Air Monitoring Laboratory (*MAML*). The MAML provides an air quality "snap shot" in time and space and thus was ideal for the type of monitoring conducted in this study.

The MAML is equipped to simultaneously measure a number of air pollutants. Relevant for the current study were particulate matter, oxides of nitrogen, carbon monoxide, sulphur dioxide and hydrocarbons. These are known pollutants emitted during fossil fuel combustion. The objectives of monitoring in the Calder neighbourhood were to determine air pollutant concentrations in the area and compare measured concentrations to established air quality objectives and concentrations outside the neighbourhood.

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Summary of Results

In general, pollutant concentrations in the neighbourhood were *not* significantly different from concentrations measured at the comparison stations outside the Calder neighbourhood. Elevated concentrations in the vicinity of Calder rail yard were probably influenced by emissions from motor vehicles on the Yellowhead trail (south of Calder yard) and diesel combustion fumes from the rail yard, Yellowhead trail emissions being the more prominent contributor. The results indicate that overall concentrations were influenced by motor vehicle emissions. This being said, periodic increases observed downwind of the rail yard area indicative of diesel combustion emissions.

The most relevant pollutants were those associated with fossil fuel combustion: oxides of nitrogen (**NO_x**), particulate matter, sulphur dioxide (**SO_2**), carbon monoxide (**CO**), polycyclic aromatic hydrocarbon (**PAHs**) and hydrocarbons.

Vehicle emissions from Yellowhead trial were probably the most significant contributor to **NO_x** concentrations measured during this study. Elevated **NO_x** concentrations were measured when monitoring sites were downwind of Yellowhead trail (wind direction had a southerly component). Lower concentrations were observed for sample periods with winds that have a northerly component. The one-hour Alberta Ambient Air Quality Objective (**AAAQO**) for NO_2 was not exceeded. **CO** concentrations measured during this study may have been influenced by vehicle emissions as well as emissions from the rail yard. Elevated concentrations were observed upwind and downwind of the Calder yard.

There was evidence to suggest that overall **particulate** concentrations measured in the Calder neighbourhood were largely influenced by vehicle emission on the Yellowhead tail. In addition, episodic increases in particulate concentrations measured downwind of the rail yard may have resulted from diesel combustion emissions in the Calder yard.

The highest **SO_2** concentrations were measured at sites that were downwind of the Calder rail yard. Thus, these elevated concentrations were most probably due to diesel combustion in Calder rail yard. However, concentrations measured were not significantly different for those measured outside of the Calder neighbourhood. Furthermore, concentrations did not exceed the one-hour AAAQO.

Hydrocarbon and particle PAHs were highest for the sample days with southerly wind. The highest concentrations were measured at sites downwind of the Yellowhead trial. Therefore

elevated concentrations near the Calder rail yard probably have significant contribution from vehicle emissions.

Monitoring method and location

Alberta Environment's mobile laboratory, MAML, was used to conduct air quality monitoring in the vicinity of Calder rail yard. A detailed description of the MAML and instruments on board are given in Appendix B. The MAML is equipped to monitor carbon monoxide, oxides of nitrogen, particulate matter, ozone, hydrocarbons, sulphur dioxide, total reduced sulphur and ammonia.

Monitoring was conducted on days with light wind speed (one-hour average < 20 km/hr). On a given survey day, monitoring was conducted at two to three downwind locations and one upwind location. Monitoring sites were classified as upwind or downwind relative to the Calder rail yard. At each of these locations data was collected for one hour in the morning and another hour in the afternoon, for a total of up to eight hours of data for each survey day. The exception was when the meteorological conditions (specifically wind speed and/or direction) changed significantly as the day progressed.

There were a total of eight monitoring locations. The photographs in Figure 1 show MAML monitoring **Sites 3 and 6**. Descriptions of all the monitoring sites are given in Table 1. The relative locations of monitoring sites in the Calder neighbourhood are illustrated in Figure 2. In addition to monitoring sites around the rail yard, monitoring sites were also located at Grand Trunk Leisure Center (**Site 3**) and Calder Community Hall (**Site 5**). Comparison monitoring was also conducted adjacent to the Edmonton Northwest air quality monitoring station (**Site 7**). Monitoring at **Site 7** was conducted for one hour on September 28, 2004 and one hour on February 25, 2005. The Edmonton Northwest air quality monitoring station was decommissioned in the fall of 2005. This station was located in a residential area, ½ kilometre northwest of the Calder neighbourhood (Figure 2). It should be noted that in addition to the Calder rail yard, the Calder neighbourhood also has the Yellowhead trail, a major arterial route, to the south.

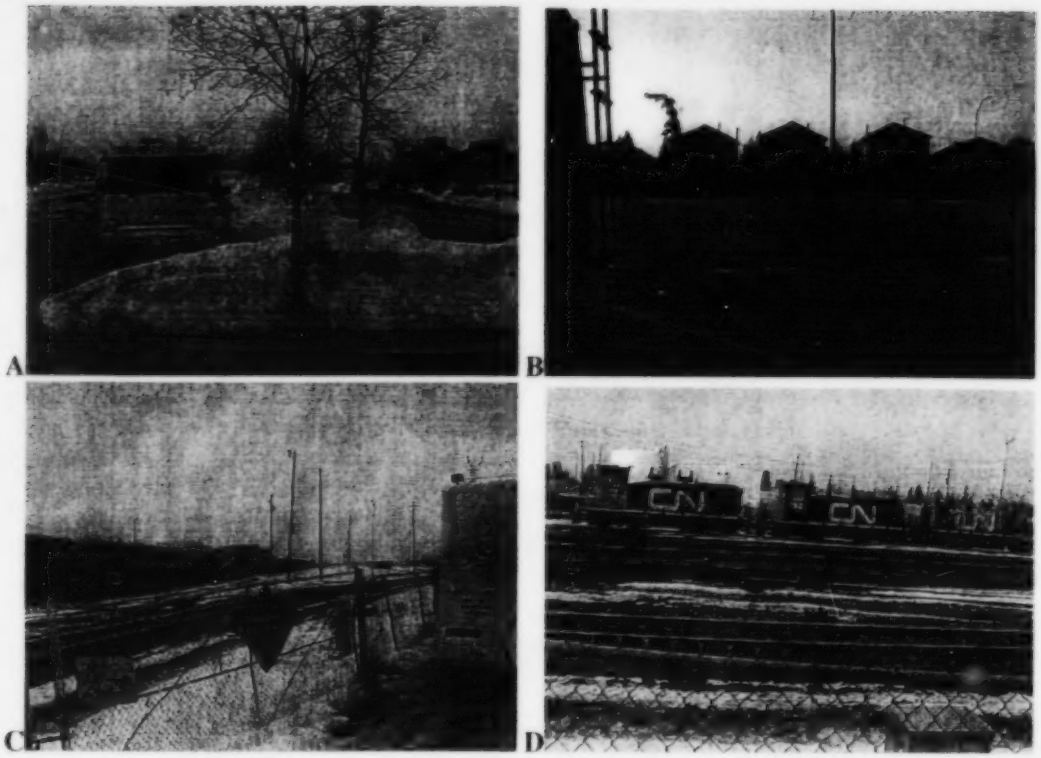

Figure 1: Photographs depicting the MAML monitoring locations. A and B depict the northerly and westerly view of Site 3, respectively. C and D depict easterly and northerly views from site 6, respectively.

Table 1: Descriptions of MAML monitoring locations

Site	Location
1	117 St & 127 Ave
2	107 St & 127 Ave
3	Grand Trunk Leisure Center, 112 St & 130 Ave.
4	West end of CN Parking Lot North Side of Yellowhead Trail (Hwy 16) accessed at 119 St.
4a	East end of CN Parking Lot North Side of Yellowhead Trail (Hwy 16) accessed at 119 St.
5	Calder Community Hall, 120 St & 128 Ave.
6	124 St. & 1/2 block North of 125 Ave.
6a	Between 124 & 125 St 1/2 block south of 127 Ave.
7	Beside Edmonton Northwest air monitoring station at 13335-127 St.

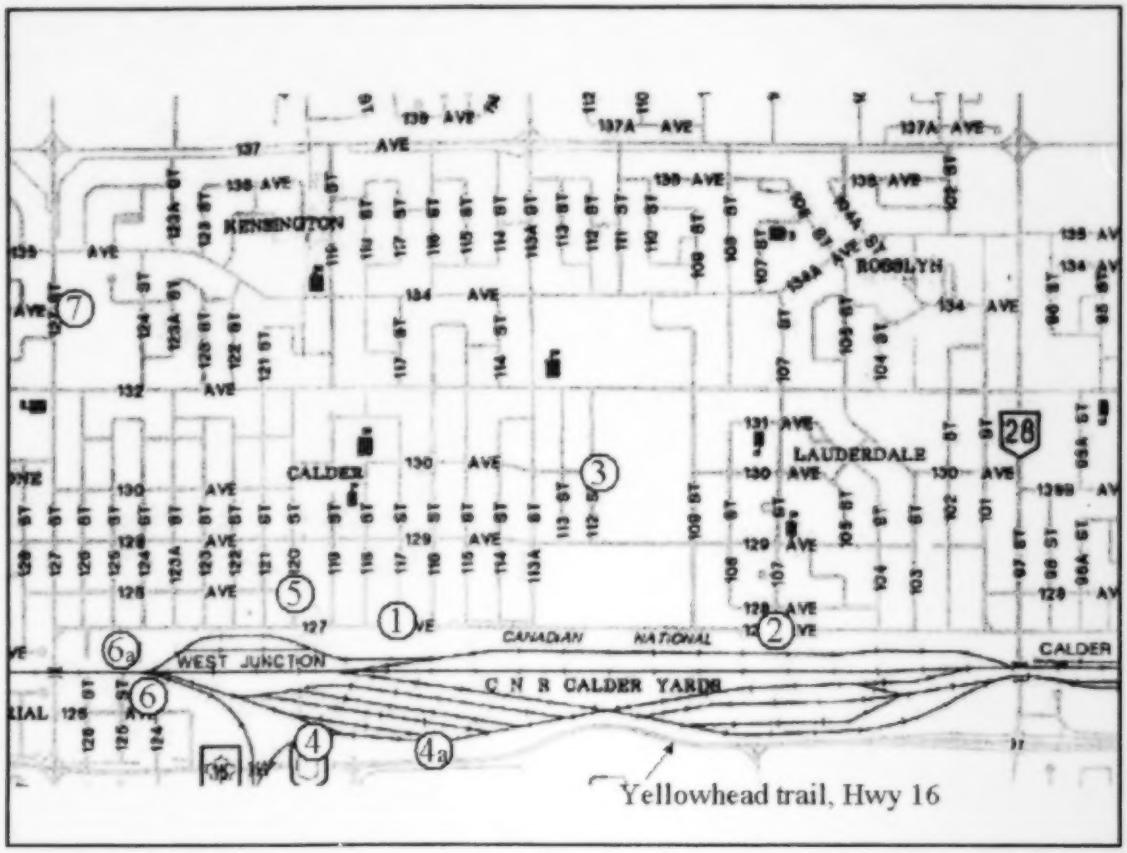

Figure 2: A map of MAML monitoring locations

Results and Discussion

There were a total of eight surveys conducted between February 2004 and March 2005. In discussing the results, the ***median one-hour average*** and the ***maximum one-hour average*** for each monitoring locations are presented. The median concentration[1] is a common way of representing the central value for environmental data. Fifty percent of the one-hour averages at a location are below the median and fifty percent are above. Thus, in using the median and maximum one-hour averages, the mid as well as the highest one-hour concentrations measured at each location are presented. These concentrations are compared to established Alberta Ambient Air Quality Objectives (***AAAQO***). In addition, data collected in the Calder neighbourhood are compared to concentrations measured at Edmonton Northwest (EdNW) and Central (EdCtrl) air monitoring stations. Data collected at the same time period as the MAML surveys were used in this comparison.

The key in Figure 2 illustrates how the median and maximum one-hour averages are represented in the following sections. Many areas in Alberta are pristine and certain pollutants that Alberta Environment monitors for are found in concentrations below the lower detection limit (***bd***) of the instruments onboard the MAML. A dataset may contain a large number of concentrations below the detection limit and a few concentrations within the operating range of the MAML instruments. In some cases, both the median and maximum one-hour averages may both be below detection limit. Such an example is shown in Figure 3 (*example Site 5*). In other cases, it is possible to have a median one-hour average concentration that is below detection limit while still having a 'detectable' maximum one-hour average concentration (*example Site 2* in Figure 3). The one-hour average concentrations at a location may also be relatively constant such that the median and maximum one-hour average concentrations are equivalent as is shown in *example Site 4* in Figure 3. ***ND*** (not determined) indicates that the parameter discussed was not monitored.

[1] Further justification for using the median concentration is presented in Appendix B.

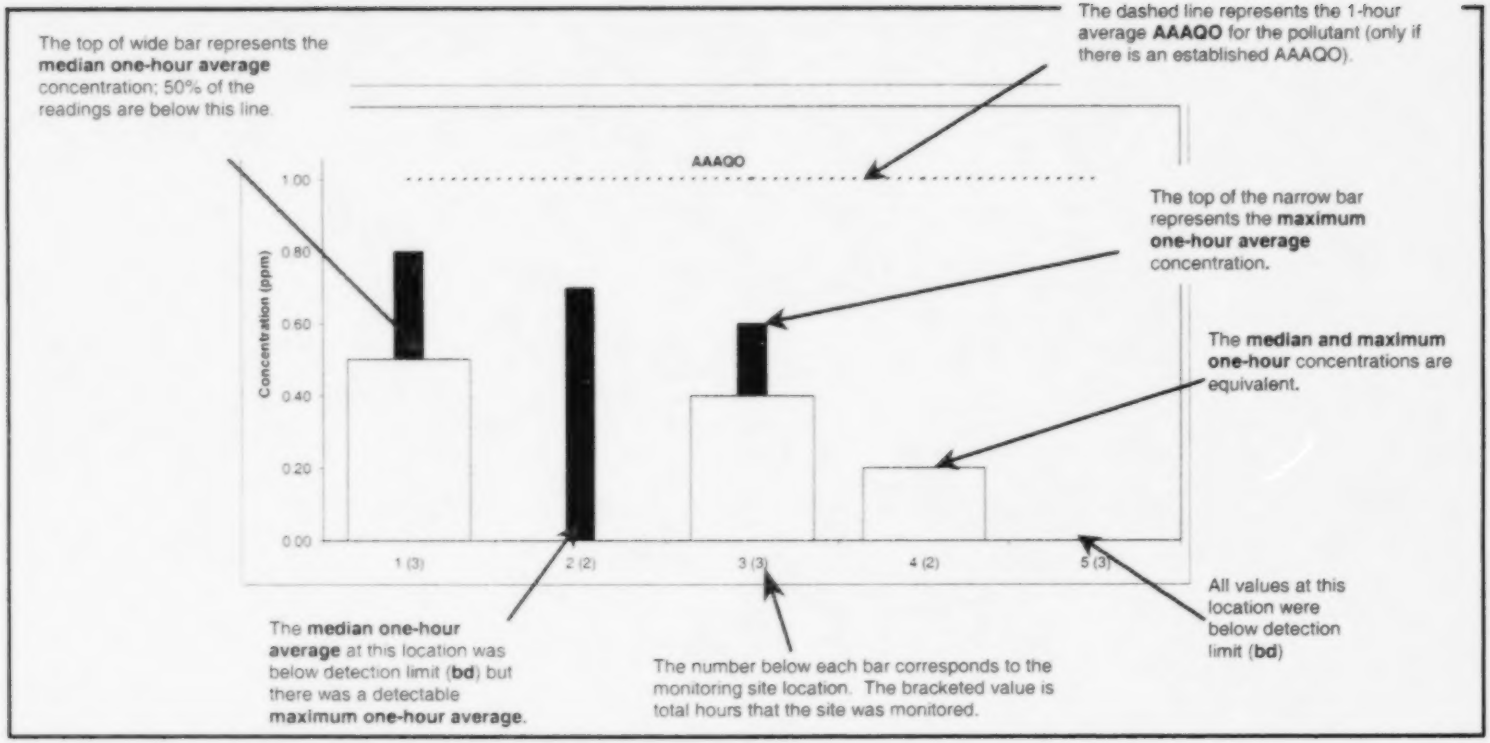
The top of wide bar represents the **median one-hour average** concentration; 50% of the readings are below this line.
The dashed line represents the 1-hour average **AAAQO** for the pollutant (only if there is an established AAAQO).
AAAQO
1.00
0.80
0.60
0.40
0.20
0.00
Concentration (ppm)
The top of the narrow bar represents the **maximum one-hour average** concentration.
The **median and maximum one-hour** concentrations are equivalent.
1 (3)
2 (2)
3 (3)
4 (2)
5 (3)
All values at this location were below detection limit (**bd**)
The **median one-hour average** at this location was below detection limit (**bd**) but there was a detectable **maximum one-hour average**.
The number below each bar corresponds to the monitoring site location. The bracketed value is total hours that the site was monitored.

Figure 3: A key for interpreting the figures in the following section.

Oxides of Nitrogen (NO, NO_2 and NO_x)

The sum of nitrogen dioxide (NO_2) and nitric oxide (NO) is known as oxides of nitrogen (NO_x). During high temperature combustion as in the burning of natural gas, coal, oil and gasoline, atmospheric nitrogen (N_2) may combine with molecular oxygen (O_2) to form two molecules of NO. In the atmosphere, NO will readily react with ozone (O_3) to form NO_2. NO_2 is a reddish-brown gas and is partially responsible for the "brown haze" observed near large cities. In Alberta, transportation is the major source of NO_x. These include automobiles, locomotives and aeroplanes.

The one-hour median NO_x concentrations in the vicinity of Calder rail yard ranged from 0.116 parts per million (ppm) (**Site 4**) to 0.047 ppm (**Site 4a**). These two sites are within a few hundred meters from each other. The notable difference in median concentration was most probably due to differences in monitoring days. Note that there are twice as many monitoring hours for **Site 4** than for **Site 4a**. The highest one-hour average concentration of 0.263 ppm was also measured at **Site 4**. Comparatively the median NO_x concentrations at Edmonton Northwest (EdNW) and Central (EdCtr) monitoring stations were 0.072 and 0.063 ppm, respectively.

Elevated NO_x concentrations (more specifically at **Site 4**) were measured when the wind direction had a southerly component; lower concentrations were noted for wind directions with northerly component. This is evident for example in concentrations measurements on September 28th 2004 when NO_x concentrations were low and the wind was from WNW. This compared to elevated concentrations measured on February 25th 2005 when the wind was from SSW (Table A4 and A6). Furthermore, concentrations downwind of the rail yard were comparable or lower than upwind monitoring locations. These observations imply that elevated NO_x concentrations during this study had contributions from motor vehicle emissions on the Yellowhead Trail.

Figure 4, 5 and 6 show NO_x, NO and NO_2 concentrations at MAML monitoring sites. These figures illustrate that NO was a notable contributor to NO_x. On average NO composed 60% of NO_x. The presence of NO indicates relatively fresh combustion emissions. Sources of NO may include vehicles on Yellowhead Trail and/or trains at the Calder yard. However, observations indicate Yellowhead trail to be the more dominant contributor. Median one-hour NO concentrations near Calder rail yard ranged from 0.029 (**Site 6a**) to 0.085 ppm (**Site 4**). The maximum one-hour average NO concentration of 0.201 ppm was also measured at **Site 4**. Not that this site was typically downwind of Yellowhead trail and upwind of the rail yard. Median

one-hour average NO concentrations at Edmonton Northwest and Central stations were 0.039 and 0.029 ppm, respectively. These values were similar to the lower range of concentrations measured near Calder rail yard.

Alberta Environment has an air quality objective for NO_2. The AAAQO for NO_2 of 0.212 ppm was not exceeded at any of the monitoring locations. In fact, with the exception of **Site 4a** where median concentrations were the lowest, concentrations at all the monitoring sites were comparable. As is illustrated in Figure 6, median concentrations in the vicinity of the Calder yard were similar to concentrations measured at Edmonton Northwest and Central stations. This being said, Table A5 illustrates that the median one-hour average NO_2 concentration in the Calder neighbourhood is notably higher than other MAML surveys (Table A5), which are typically conducted in rural areas away from vehicle emissions.

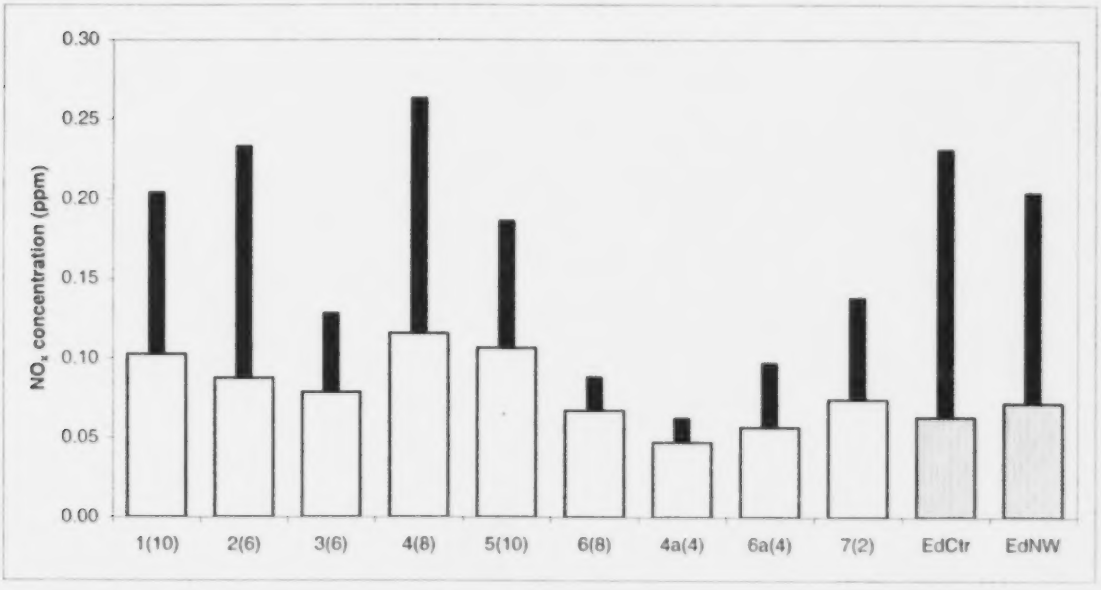

Figure 4: Median and maximum one-hour average concentrations for NO_x. EdCtr is Edmonton Central air quality monitoring station and EdNW is Edmonton Northwest air quality monitoring station.

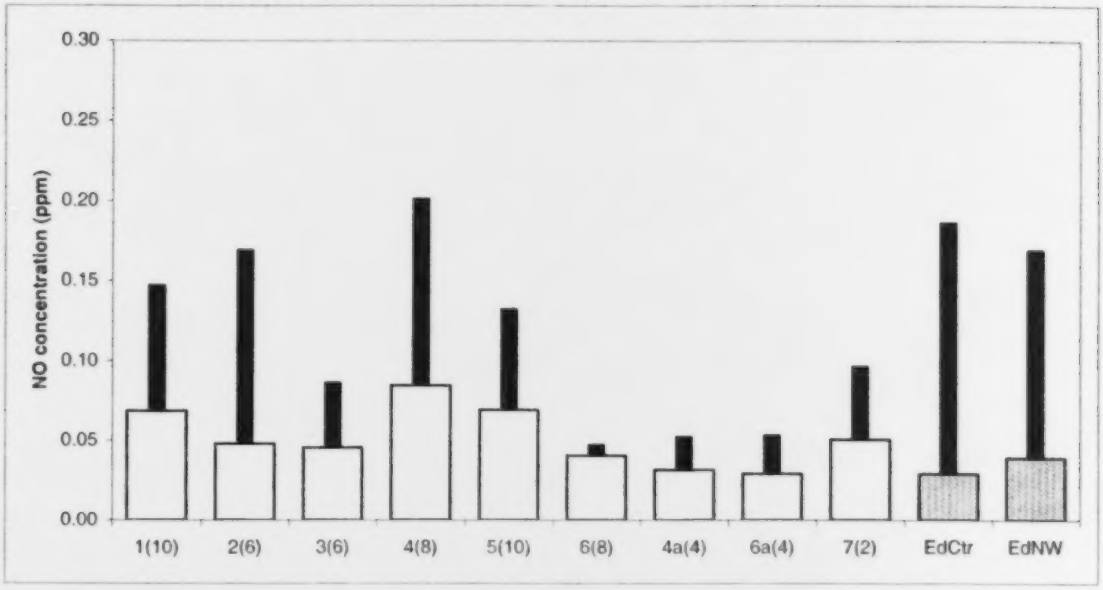

Figure 5: Median and maximum one-hour concentrations for NO. EdCtr is Edmonton Central air quality monitoring station and EdNW is Edmonton Northwest air quality monitoring station.

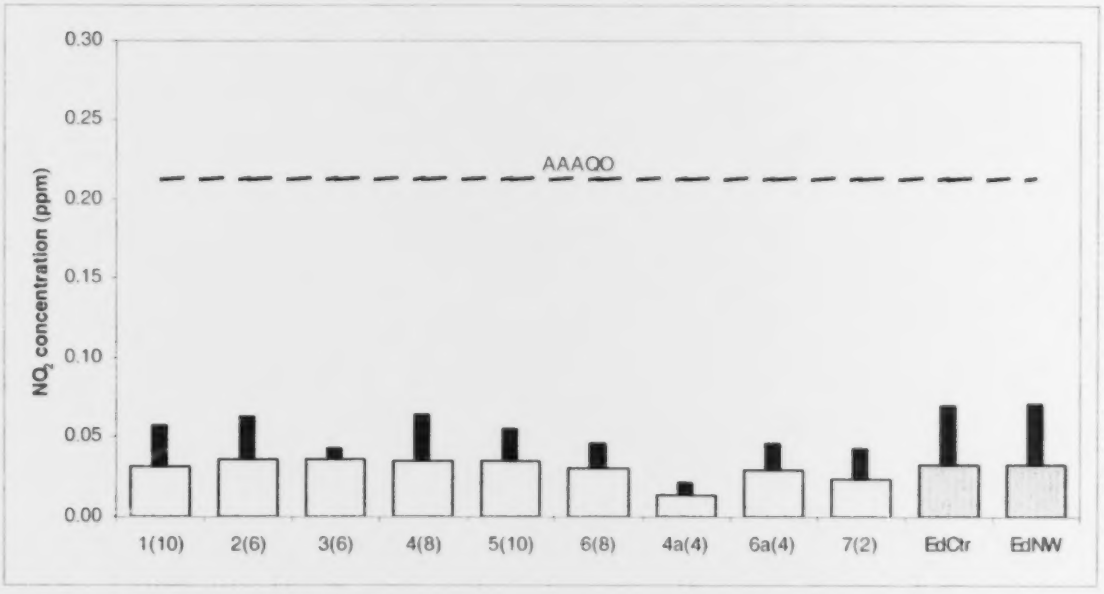

Figure 6: Median and maximum one-hour concentrations for NO_2. EdCtr is Edmonton Central air quality monitoring station and EdNW is Edmonton Northwest air quality monitoring station.

Particulate Matter (TSP, PM_{10} and $PM_{2.5}$)

Inhalable particulates are particulate matter less than 10 micrometres in aerodynamic diameter (PM_{10}). Sources of PM_{10} include soil dust, road dust, agricultural dust (e.g., harvest), smoke from forest fires and wood burning, vehicle exhaust and industrial emissions. Respirable particulates are particulate matter less than 2.5 micrometres in aerodynamic diameter ($PM_{2.5}$). $PM_{2.5}$ are small enough to penetrate into the lungs. Respirable particulates may form in the atmosphere and/or arise from combustion sources such as vehicle exhaust, industrial emissions and wood burning. Total suspended particles (TSP) range in size from 0.001 to 500 micrometer; this group includes both PM_{10} and $PM_{2.5}$.

Particulate matter from diesel exhaust was of particular concern to residents of Calder neighbourhood. The median one-hour average TSP concentrations in the Calder yard area were variable, ranging from 4 $\mu g/m^3$ (at **Site 6a**) to 115 $\mu g/m^3$ (at **Site 4**). The median one-hour average PM_{10} concentration in the Calder yard area ranged from 2 $\mu g/m^3$ (at **Site 6a**) to 76 $\mu g/m^3$ (at **Site 4**). Similarly the highest median $PM_{2.5}$ concentration was measured at **Site 4** with a median one-hour average of 11 $\mu g/m^3$. Median one-hour average $PM_{2.5}$ concentration at **Site 6a** was below detection limit. The results indicate that particulate concentration was highest at **Site 4.** For over 60% of the survey, **Site 4** was upwind of the rail yard and downwind of Yellowhead trail. **Site 6a**, where the lowest median concentrations were measured, was located downwind of the diesel shop where engine repairs are carried out and engines are left idling. Thus ***on average*** elevated particulate matter concentration in the area had significant contribution from motor vehicle exhaust on Yellowhead highway. Median $PM_{2.5}$ concentration at Edmonton Central and Northwest air monitoring stations were comparable to those measured in the Calder neighbourhood. TSP was not measured at these stations, and PM_{10} was only measured at Edmonton Northwest. Elevated median one-hour average at **Site 7** may be due to the ruminants of local rush hour traffic; one of the two sample hours (February 25, 2005) was conducted between 9:30 and 10:40 in the morning.

The maximum one-hour average particulate concentrations at a number of the sites were notably higher than the median concentrations. Indicating that particulate concentrations at some of the site were highly variable. The highest particulate concentrations were measured at **Site 5** (Calder community Hall), on the north side of Calder yard. Maximum one-hour average concentration at **Site 1,** located east of **Site 5** was also similarly elevated. These elevated

concentrations were measured when the wind direction was westerly and south-westerly (Table A4 and A6). During such meteorological conditions, **Site 1** and **5** were possibly influenced by emissions from the west end of the rail yard. Thus, while vehicle emissions had influence on the overall particulate concentrations measured. Episodic increases in particulate concentration downwind of Calder yard may have resulted from diesel combustion emission that occurred at the west end of the rail yard, where the diesel shop is located.

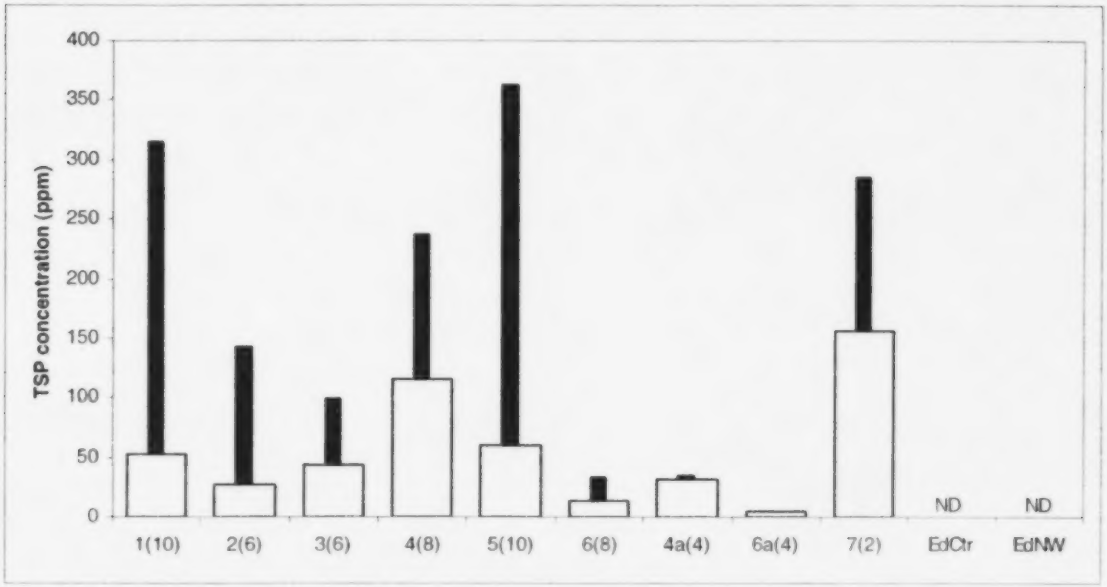

Figure 7: Median and maximum one-hour average concentrations for TSP. TSP was not monitored at Edmonton central (EdCtr) and Edmonton Northwest (EdNW) air quality monitoring stations.

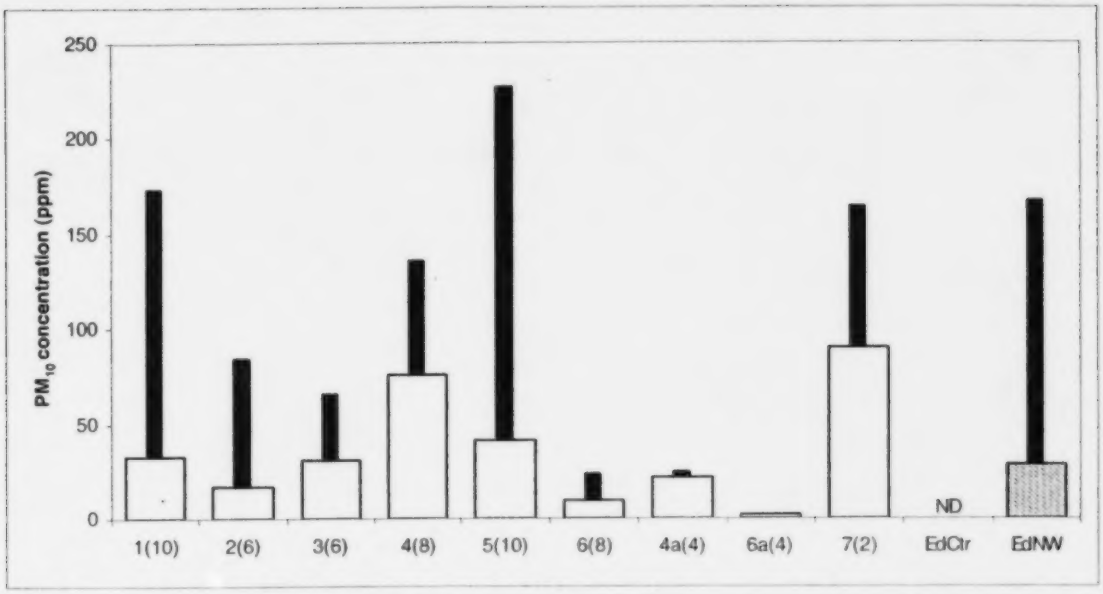

Figure 8: Median and maximum one-hour average concentrations for PM_{10}. PM_{10} was not monitored at Edmonton Central (EdCtr) air quality monitoring station.

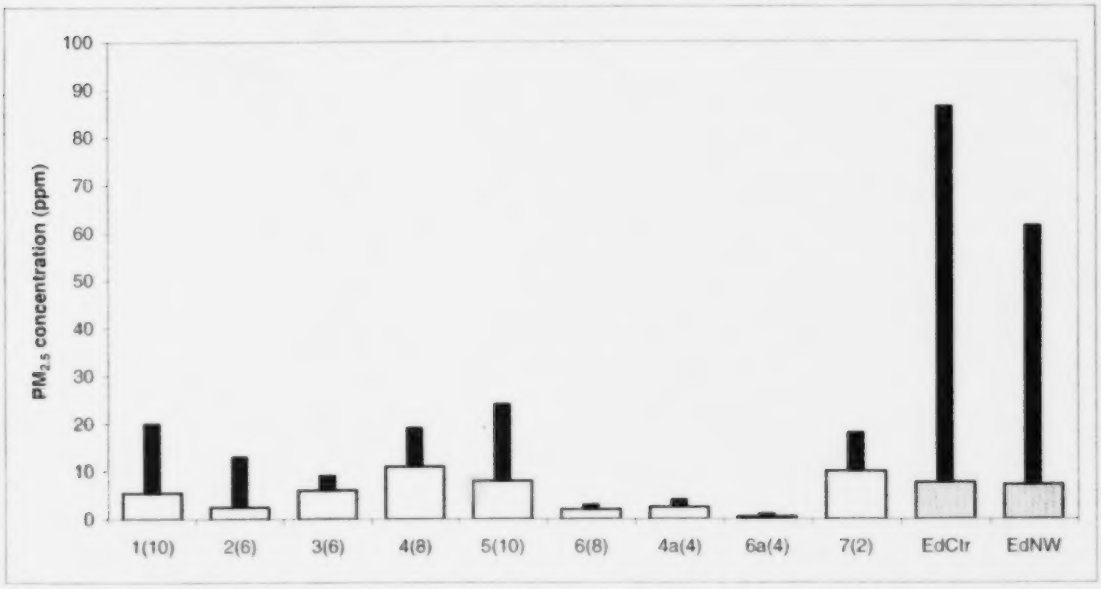

Figure 9: Median and maximum one-hour average concentrations for $PM_{2.5}$. EdCtr is Edmonton Central air quality monitoring station and EdNW is Edmonton Northwest air quality monitoring station. Maximum one-hour average $PM_{2.5}$ concentration at EdCtr and EdNW were measured on February 24th. On this day particle concentration was not measured by the MAML due to equipment failure. However, the data illustrates that particle concentration significantly higher than those measured at Calder neighbour hood can be measured at other areas of the city.

Sulphur Dioxide (SO_2)

In Alberta, natural gas processing plants are responsible for close to half of the SO_2 emissions in the province. Other sources include gas plant flares, oil sands facilities, oil refineries, pulp and paper mills and fertilizer plants. SO_2 can also be produced during the combustion of sulphur containing fuels such as coal and oil. Coal fired power plants and diesel powered transportations such as trucks, locomotives and marine vessels can be SO_2 sources.

SO_2 concentrations at all of the monitoring locations were notably lower than the one-hour AAAQO of 0.172 ppm (Figure 10). Median one-hour average concentrations in the Calder yard area ranged from below detection limit to 0.004 ppm. The highest median was observed at **Site 5** (Calder community hall). The maximum one-hour concentrations ranged from 0.001 to 0.006 ppm. The maximum concentration was measured at **Site 1** and **Site 4**. Comparatively, the median and maximum one-hour SO_2 concentrations at **Site 7** (beside Edmonton Northwest monitoring station) were 0.002 and 0.004 ppm. SO_2 was not monitored at the permanent monitoring stations.

Elevated SO_2 concentrations were observed on monitoring days with low wind speed. Concentrations were higher for monitoring locations north of the yard, when these sites were downwind of the rail yard (Table A4 and A6). Thus, elevated SO_2 concentrations north of the Calder yard are possibly due to diesel combustion exhaust from trains. This being said levels in the area were not significantly different from concentrations measured outside of the Calder neighbourhood (**Site 7**) or at other MAML surveys (Table A5).

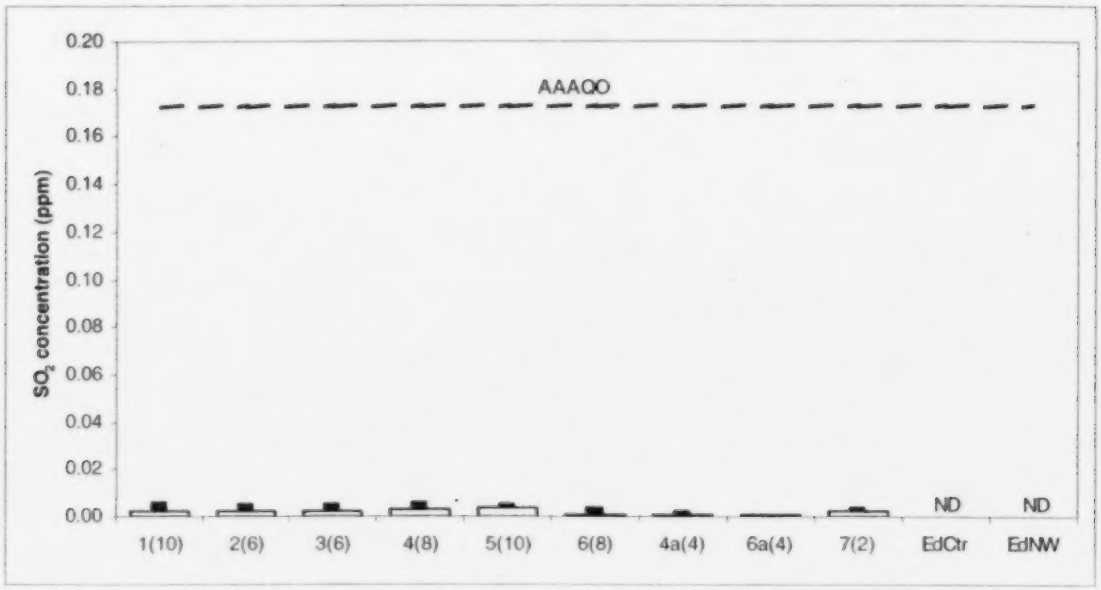

Figure 10: Median and maximum one-hour average concentrations for SO_2. Sulphur dioxide was not monitored at Edmonton Northwest (EdNW) and Central (EdCtrl) air quality monitoring stations.

Carbon Monoxide (CO)

Carbon monoxide (CO) is emitted into the atmosphere primarily from incomplete combustion of fuels such as gasoline, oil and wood. Sources of CO include motor vehicles, fireplaces, industry, and natural gas combustion and forest fires.

During other MAML surveys, median one-hour CO concentration was for the most part about 0.2 ppm (Table A5). The highest median one-hour concentration of 0.5 ppm was measured in Banff (2003), where motor vehicle emissions were a possible source of elevated CO. The median one-hour average CO concentrations in the Calder yard area ranged from 0.2 to 1.0 ppm. The lowest concentration was measured at **Site 4a** (East end of CN parking lot) and the highest concentration was determined for **Site 1** (at the interception of 117 street and 127 avenue, north of the Calder rail yard). Median concentration at **Sites 2**, **4**, **5** and **7** were comparable to **Site 1**, with concentrations of 0.8, 0.8, 0.7 and 0.8 ppm, respectively. **Sites 1**, **2** and **5** are located on the north side of the rail yard and were predominantly downwind of the yard. One-hour average concentrations at Edmonton Northwest and Central air quality monitoring stations were not significantly different with median of 0.6 and 0.7 ppm, respectively.

On the whole, CO concentration in the Calder neighbourhood was not especially different from concentrations measured outside of the Calder neighbourhood. Elevated CO concentration possibly had contributions from vehicles on neighbourhood roads, vehicles on Yellowhead trail (Hwy 16) and trains at Calder rail yard. With the maximum one-hour average concentrations ranging from 0.2 to 2.3 ppm, concentrations did not exceed the one-hour AAAQO for CO of 13 ppm (Figure 11).

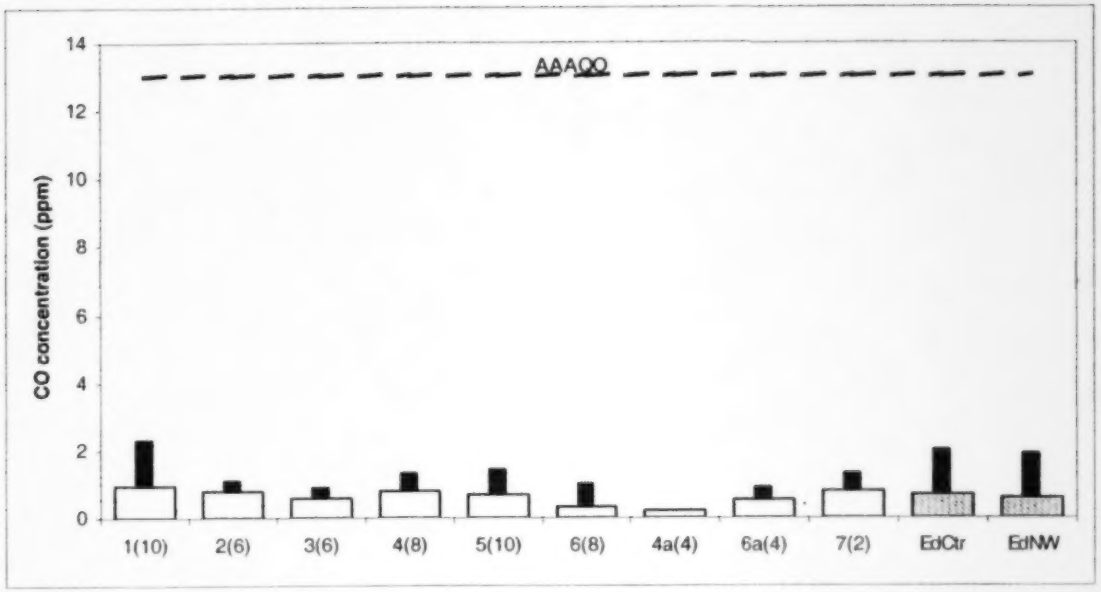

Figure 11: Median and maximum one-hour average concentrations for carbon monoxide. EdCtr is Edmonton Central air quality monitoring station and EdNW is Edmonton Northwest air quality monitoring station.

Polycyclic aromatic hydrocarbon (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are formed through incomplete combustion and consist of two or more benzene rings. Vehicle exhaust, wood smoke from residential use, industrial use and forest fires are all sources of PAHs. PAHs can be found as a gas or condensed onto particles. Larger PAHs (containing more benzene rings) tend to attach onto particles. ***It is these types of PAHs that are measured by the MAML.*** Particle PAHs have been associated with soot from diesel combustion[2] and thus are of special importance to the current study. There are more than 100 different PAHs with varying levels of toxicity. PAHs usually occur as complex mixtures rather than single compounds.

The median PAHs concentrations in the Calder yard area were notably higher than any other MAML survey (Table A5). Median one-hour PAHs concentrations at other MAML surveys (normally conducted in rural areas) were typically about 1 ng/m^3. The median one-hour average concentrations at monitoring locations near the Calder yard ranged from 12 ng/m^3 at **Site 6a** to 35 ng/m^3 at **Site 4**. The maximum concentration of 154 ng/m^3 was measured at **Site 4**. Median one-hour average PAHs at **Site 7** (beside Edmonton Northwest air monitoring station) was 17 ng/m^3. Due to the urban location of the study, PAHs concentrations measured were higher than other MAML surveys. However as indicated by concentrations measured at **Site 7**, overall PAHs concentrations in the Calder area were comparable to levels measured at other urban locations.

There were monitoring periods when PAHs concentrations were elevated relative to those observed at the comparison location (**Site 7**). Elevated concentrations at **Site 4** (where the highest concentrations were measured) were observed when the site was downwind of Yellowhead trail, for example February 25 and March 1 and 2, 2005 (Table A4 and A6). The lowest concentrations for the study were measured when the wind had a northerly component (for example February 13 and September 28, 2004, Table A5 and A6). During such meteorological conditions, PAHs concentrations less than 10 ng/m^3 were measured even for the monitoring locations that were downwind of the rail yard. Much like CO and NO_x, the more significant contributor to elevated PAHs concentrations in the Calder neighbourhood is probably motor vehicles emissions on Yellowhead trail.

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[2] Scheepers, P.T. J. and Bos, R.P. Combustion of diesel fuel from a toxicological perspective. I. Origin of incomplete combustion products. *Environmental Sciences and Pollution Management*, **1992**, 64, pp149-161.

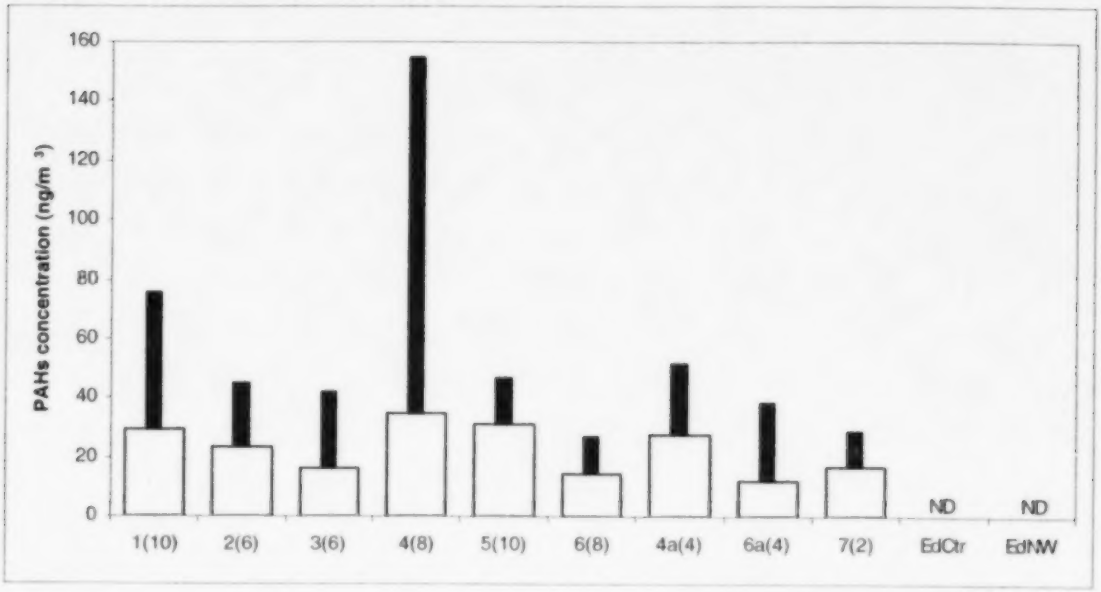

Figure 12: Median and maximum one-hour average concentrations for polycyclic aromatic hydrocarbon. Polycyclic aromatic hydrocarbons were not measured at Edmonton Central (EdCtr) and Northwest (EdNW) air quality monitoring stations.

Hydrocarbons

The term "total hydrocarbons" (THC) refers to a broad family of chemicals that contain carbon and hydrogen atoms. Methane (CH_4), a non-reactive hydrocarbon, is the most common hydrocarbon in the earth's atmosphere. As a result, for most measurements around Alberta, concentrations of THC and CH_4 are equivalent (Table A5) and a background concentration of about 2 ppm is typically measured. Reactive hydrocarbons (RHC) form the remaining fraction of THC. RHC are important because: (1) they can react with oxides of nitrogen in the presence of sunlight to form ozone; and (2) some RHC can be toxic (at high concentrations) to humans, animals or vegetation. Typically RHC concentrations measured during MAML surveys are close to instrument detection limit. The major sources of hydrocarbons in Alberta include vegetation, vehicle emissions, gasoline marketing and storage tanks, petroleum and chemical industries and fugitive emissions such as leaks and evaporation of solvents.

The one-hour median total hydrocarbon and methane concentrations measured during this study were all above background concentrations (~2 ppm). Hydrocarbon concentrations are shown in Figures 13 to 14. With the exception of **Site 4a**, median THC concentrations at all other sites were comparable with concentrations ranging from 2.7 to 3.1 ppm. The median one-hour concentration at **Site 4a** was 2.3 ppm. Similarly CH_4 concentration at all monitoring locations except **Site 4a** were comparable with median one-hour averages ranging from 2.4 to 2.7 ppm. Median one-hour average RHC at these locations ranged from 0.2 to 0.5 ppm. Median hydrocarbon concentration at the comparison monitoring location (**Site 7**) was not significantly different (Figures 13-15). Thus overall, hydrocarbon concentrations in the vicinity of Calder rail yard were comparable to levels measured in an urban area.

The maximum THC concentration of 3.9 ppm was measured at **Site 1** on March 1, 2005. As is evident in **Table A4,** concentrations at all other sites were also elevated on this sample day when wind direction was from the southwest. One-hour average CH_4 concentrations on this day ranged from 2.8 to 3.3 ppm. One-hour average RHC concentrations ranged from 0.5 to 0.7 ppm. Similar weather conditions and hydrocarbon concentrations were observed on February 25th and March 2nd 2005. The maximum hydrocarbon concentrations at almost all the Calder sites were measured on these three sample days (February 25th, March 1 and March 2). Recall that PAHs concentrations were also elevated these days when the wind direction had a southerly component and the Calder neighbourhood was downwind of the Yellowhead trail. Therefore, elevated

hydrocarbon concentrations near the Calder rail yard probably have significant contribution from vehicle emissions on Yellowhead trail.

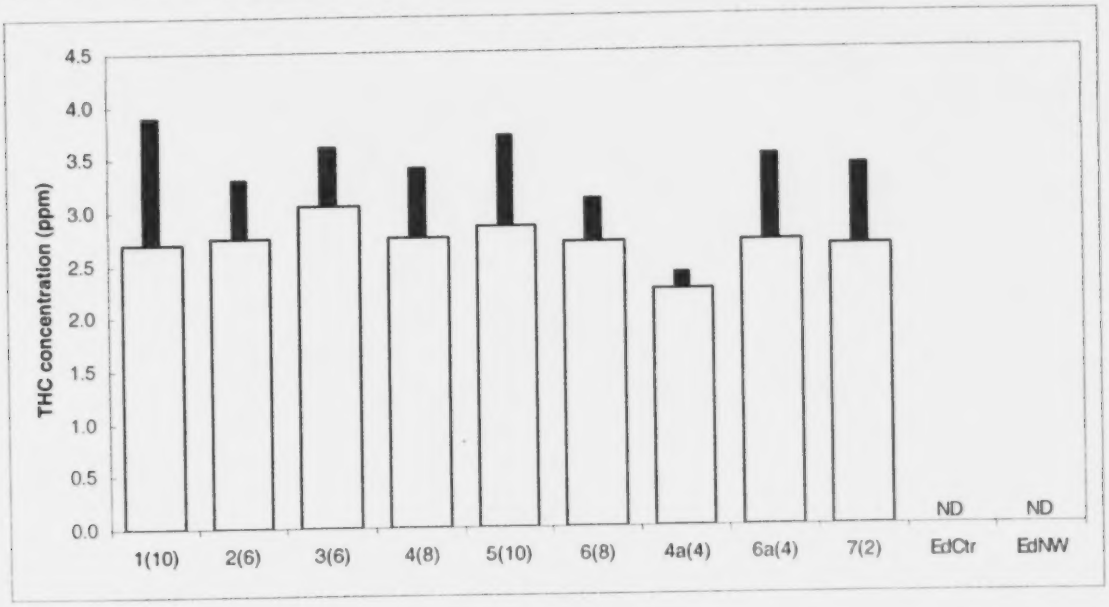

Figure 13: Median and maximum one-hour average concentrations for total hydrocarbons. Total hydrocarbons were not measured at Edmonton Central (EdCtr) and Northwest (EdNW) air quality monitoring stations.

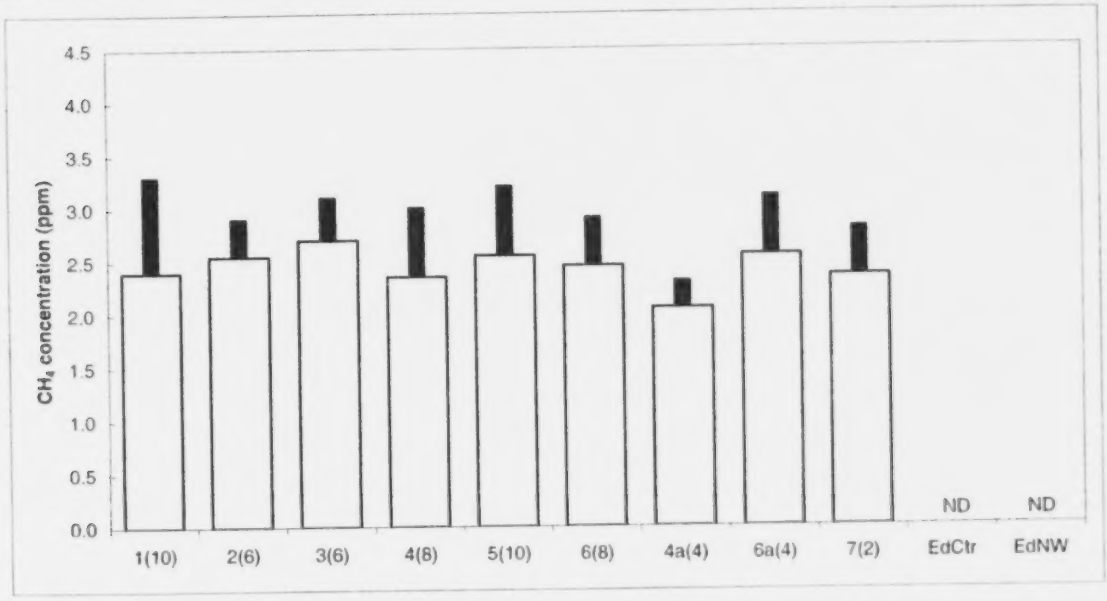

Figure 14: Median and maximum one-hour average concentrations for methane. Methane was not measured at Edmonton Central (EdCtr) and Northwest (EdNW) air quality monitoring stations.

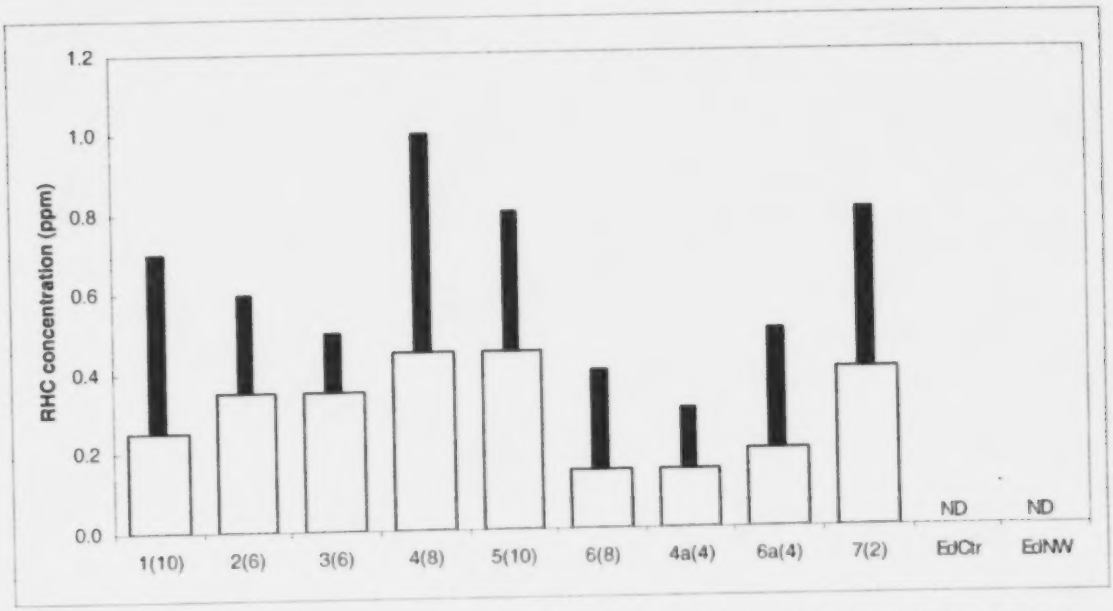

Figure 15: Median and maximum one-hour average concentrations for reactive hydrocarbons. Reduced hydrocarbons were not measured at Edmonton Central (EdCtr) and Northwest (EdNW) air quality monitoring stations.

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Appendix A

Table A1: Median one-hour average concentrations for the various monitoring locations

Site	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
1(10)	1.0	0.011	2.7	2.4	0.3	0.002	0.069	0.032	0.103	0.008	bd	0.001	53	33	6	30
2(6)	0.8	0.006	2.8	2.6	0.4	0.002	0.048	0.037	0.088	0.005	0.001	bd	28	17	3	23
3(6)	0.6	0.010	3.1	2.7	0.4	0.002	0.046	0.037	0.079	0.007	bd	bd	43	31	6	16
4(8)	0.8	0.015	2.8	2.4	0.5	0.003	0.085	0.035	0.116	0.012	0.001	0.001	115	76	11	35
5(10)	0.7	0.008	2.9	2.6	0.5	0.004	0.069	0.035	0.107	0.008	bd	0.001	60	41	8	31
6(8)	0.3	0.008	2.7	2.5	0.2	0.001	0.041	0.030	0.067	0.010	0.001	bd	13	10	2	14
4a(4)	0.2	0.018	2.3	2.1	0.2	0.001	0.032	0.014	0.047	0.007	0.002	bd	32	22	3	28
6a(4)	0.5	0.011	2.7	2.6	0.2	bd	0.029	0.029	0.057	0.008	0.001	0.001	4	2	bd	12
7(2)	0.8	0.023	2.7	2.4	0.4	0.002	0.051	0.024	0.074	0.004	0.001	bd	156	90	10	17

Table A2: Maximum one-hour average concentrations for the various monitoring locations

Site	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
1(10)	2.3	0.036	3.9	3.3	0.7	0.006	0.147	0.057	0.204	0.018	0.002	0.002	314	173	20	76
2(6)	1.1	0.022	3.3	2.9	0.6	0.005	0.169	0.063	0.233	0.017	0.002	0.002	142	84	13	45
3(6)	0.9	0.021	3.6	3.1	0.5	0.005	0.086	0.043	0.128	0.010	0.001	0.001	99	66	9	42
4(8)	1.3	0.034	3.4	3.0	1.0	0.006	0.201	0.064	0.263	0.033	0.003	0.003	236	136	19	154
5(10)	1.4	0.019	3.7	3.2	0.8	0.005	0.132	0.055	0.186	0.009	0.003	0.002	362	227	24	47
6(8)	1.0	0.020	3.1	2.9	0.4	0.004	0.047	0.046	0.088	0.015	0.002	0.001	33	23	3	27
4a(4)	0.2	0.035	2.4	2.3	0.3	0.002	0.052	0.021	0.062	0.009	0.002	0.000	34	24	4	52
6a(4)	0.9	0.022	3.5	3.1	0.5	0.001	0.053	0.046	0.097	0.010	0.002	0.001	4	2	1	39
7(2)	1.3	0.038	3.4	2.8	0.8	0.004	0.096	0.043	0.138	0.008	0.001	0.001	285	164	18	29

Notes:

ppm - parts per million **ng/m^3** = nanograms per cubic meter **$\mu g/m^3$** = micrograms per cubic meter

bd – below detection limit of analyzer

Table A4: Chronological listing of one-hour average concentrations

Date	Times	Site	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H2S PPM	TSP µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	PAH ng/m³
11-Feb-04	08:23 to 09:23	1	1.2	0.005	2.7	2.3	0.4	bd	0.109	0.034	0.140	0.007	0.002	0.001	22	8	1	38
	09:27 to 10:30	2	0.8	0.008	2.4	2.2	0.4	bd	0.074	0.034	0.106	0.004	0.001	bd	13	6	1	33
	10:35 to 11:48	3	0.7	0.013	2.4	2.2	0.4	bd	0.054	0.031	0.082	0.004	0.001	bd	17	8	1	17
	11:58 to 12:58	4	1.0	0.012	2.4	2.1	0.6	0.002	0.124	0.035	0.153	0.017	0.001	bd	47	24	4	55
	13:08 to 14:12	5	0.7	0.019	2.1	2.0	0.6	0.001	0.046	0.026	0.070	0.009	bd	bd	11	6	1	14
	14:18 to 15:19	3	0.5	0.021	2.5	2.4	0.2	0.001	0.021	0.025	0.044	0.006	bd	bd	7	4	1	10
	15:24 to 16:23	1	0.7	0.018	2.5	2.4	0.1	0.002	0.022	0.029	0.050	0.005	bd	bd	11	6	1	20
	16:38 to 17:37	5	0.9	0.005	2.6	2.5	0.2	0.002	0.072	0.039	0.110	0.007	bd	0.001	11	5	1	30
	17:42 to 18:41	2	1.1	0.001	2.6	2.5	0.2	0.002	0.057	0.042	0.098	0.007	bd	bd	17	8	1	33
13-Feb-04	07:43 to 08:44	2	0.5	0.015	2.3	2.0	0.3	bd	0.014	0.022	0.035	0.006	0.002	0.002	1	1	bd	13
	08:50 to 09:50	4	0.2	0.018	2.2	2.0	0.2	bd	0.037	0.021	0.056	0.006	0.003	0.001	ND	ND	ND	9
	09:53 to 10:53	4a	0.2	0.023	2.2	2.0	0.2	bd	0.014	0.021	0.035	0.006	0.002	bd	5	3	1	8
	11:09 to 12:09	6	bd	0.020	2.2	2.1	0.1	bd	0.029	0.023	0.051	0.006	0.001	0.001	4	2	1	4
	12:13 to 13:13	6a	0.2	0.021	2.2	2.1	0.1	bd	0.025	0.018	0.043	0.007	0.001	0.001	4	2	bd	3
	13:13 to 14:13	6a	0.1	0.022	2.2	2.1	0.1	bd	0.017	0.015	0.032	0.006	0.001	0.001	4	2	1	3
	14:20 to 15:20	6	0.1	0.019	2.2	2.2	bd	bd	0.033	0.023	0.054	0.010	0.001	0.001	4	2	bd	6
24-Feb-04	14:23 to 15:23	5	0.6	0.012	3.2	2.8	0.5	0.004	0.024	0.029	0.055	0.008	0.003	0.002	ND	ND	ND	5
	15:31 to 16:32	6	0.4	0.008	3.1	2.7	0.4	0.004	0.042	0.046	0.088	0.008	0.002	0.001	ND	ND	ND	16
	16:46 to 17:47	3	0.5	0.004	3.2	2.8	0.4	0.003	0.033	0.042	0.075	0.008	0.001	0.001	ND	ND	ND	7
	17:52 to 18:52	6A	0.8	0.001	3.5	3.1	0.5	0.001	0.053	0.046	0.097	0.009	0.002	0.001	ND	ND	ND	20
	18:52 to 19:51	6A	0.9	0.001	3.2	3.0	0.3	0.001	0.033	0.040	0.070	0.010	0.001	0.001	ND	ND	ND	39
	20:06 to 21:06	6	0.7	0.001	3.1	2.9	0.3	0.001	0.045	0.037	0.080	0.013	0.001	0.001	ND	ND	ND	13
	21:06 to 22:06	6	1.0	0.001	3.1	2.9	0.3	0.002	0.047	0.041	0.085	0.010	0.001	bd	ND	ND	ND	20
	22:07 to 22:35	6	1.0	0.001	3.0	2.9	0.2	0.001	0.044	0.038	0.080	0.010	0.001	bd	ND	ND	ND	21

Continued ...

Table A4: Chronological listing of one-hour average concentrations continued from the previous page

Date	Times	Site	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H2S PPM	TSP µg/m³	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	PAH ng/m³
31-Aug-04	06:35 to 07:35	1	0.6	0.003	2.2	2.0	0.2	0.003	0.058	0.025	0.081	0.012	0.001	0.001	61	33	5	31
	07:38 to 08:39	5	0.3	0.005	2.2	2.0	0.2	0.003	0.087	0.021	0.106	0.009	bd	bd	43	28	4	32
	08:43 to 09:44	6	0.2	0.008	2.2	2.1	0.1	0.002	0.039	0.019	0.046	0.015	bd	bd	22	17	3	27
	09:51 to 10:52	4A	0.2	0.009	2.3	2.3	bd	0.002	0.052	0.012	0.059	0.008	0.002	bd	31	22	4	48
	10:57 to 11:57	1	0.1	0.011	2.2	2.2	0.1	0.001	0.034	0.012	0.041	0.008	bd	bd	43	30	4	15
	12:00 to 12:59	5	0.1	0.009	2.3	2.2	0.1	0.002	0.056	0.021	0.075	0.006	bd	bd	55	36	5	15
	13:04 to 14:03	6	0.1	0.012	2.4	2.2	0.1	0.001	0.029	0.020	0.046	0.004	bd	bd	33	23	3	13
	14:14 to 15:14	4A	0.1	0.013	2.4	2.1	0.3	0.002	0.049	0.015	0.062	0.009	bd	bd	34	24	3	52
28-Sep-04	08:22 to 09:24	5	0.7	0.006	2.4	2.2	0.2	0.002	0.063	0.031	0.094	0.001	0.001	0.001	362	227	24	47
	09:30 to 10:31	1	2.3	0.016	2.5	2.2	0.3	bd	0.018	0.017	0.035	0.006	bd	bd	47	32	4	14
	10:45 to 11:45	4	0.1	0.034	2.0	1.8	0.2	bd	0.003	0.005	0.009	0.001	0.001	bd	26	18	2	1
	11:47 to 12:48	4A	0.2	0.035	2.0	1.8	0.1	bd	0.005	0.006	0.010	0.001	0.001	bd	33	21	2	7
	12:49 to 13:49	4	0.2	0.034	1.9	1.9	0.1	bd	0.007	0.009	0.015	0.001	bd	bd	36	25	3	5
	13:57 to 14:56	7	0.3	0.038	1.9	1.9	bd	bd	0.005	0.005	0.010	bd	0.001	bd	27	16	2	5
25-Feb-05	06:09 to 07:09	2	0.8	0.003	3.1	2.8	0.3	0.002	0.039	0.039	0.077	0.003	0.001	0.001	38	25	4	11
	07:15 to 08:20	1	1.7	0.004	3.2	2.7	0.6	0.003	0.147	0.057	0.204	0.009	0.001	0.002	134	80	11	76
	08:22 to 09:23	5	1.4	0.005	3.2	2.7	0.6	0.004	0.127	0.053	0.179	0.007	0.001	0.002	132	77	11	37
	09:28 to 10:40	7	1.3	0.007	3.4	2.8	0.8	0.004	0.096	0.043	0.138	0.008	0.001	0.001	285	164	18	29
	10:48 to 11:47	4	1.3	0.006	3.4	2.6	1.0	0.005	0.201	0.064	0.263	0.033	0.002	0.003	222	131	18	120
	11:54 to 12:53	5	0.8	0.014	3.1	2.6	0.8	0.004	0.072	0.045	0.116	0.009	bd	0.001	178	110	14	24
	12:58 to 13:57	2	0.6	0.022	2.9	2.6	0.6	0.003	0.024	0.030	0.053	0.004	0.001	bd	77	49	7	11
1-Mar-05	06:17 to 07:18	1	1.0	0.002	3.9	3.3	0.6	0.004	0.100	0.045	0.145	0.018	0.002	0.002	59	38	7	41
	07:27 to 08:27	5	1.3	0.003	3.7	3.2	0.5	0.005	0.132	0.055	0.186	0.007	0.002	0.002	60	41	8	42
	08:33 to 09:33	3	0.9	0.006	3.6	3.1	0.5	0.005	0.086	0.042	0.128	0.010	0.001	0.001	66	46	9	26
	09:44 to 11:01	4	1.2	0.005	3.4	3.0	0.5	0.006	0.199	0.059	0.256	0.030	0.002	0.003	236	136	19	154
	11:08 to 12:09	1	0.9	0.010	3.4	2.8	0.7	0.006	0.082	0.044	0.125	0.010	0.001	0.001	314	173	20	28
	12:12 to 13:13	4	0.7	0.018	3.3	2.8	0.5	0.005	0.045	0.034	0.078	0.009	0.001	0.001	115	76	11	14

Continued ...

Table A4: Chronological listing of one-hour average concentrations continued from previous page

Date	Times	Site	CO PPM	O_3 PPM	THC PPM	CH_4 PPM	RHC PPM	SO_2 PPM	NO PPM	NO_2 PPM	NO_x PPM	NH_3 PPM	TRS PPM	H2S PPM	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
2-Mar-05	06:13 to 07:17	1	1.2	0.036	3.3	3.2	0.1	0.002	0.079	0.044	0.124	0.005	bd	0.002	44	33	6	46
	07:21 to 08:20	3	0.9	0.002	3.2	3.1	0.1	0.002	0.066	0.043	0.110	0.004	bd	0.001	43	31	6	42
	08:30 to 09:29	2	1.1	0.004	3.3	2.9	0.4	0.005	0.169	0.063	0.233	0.017	bd	0.002	142	84	13	45
	09:41 to 10:40	4	0.9	0.007	3.1	2.7	0.4	0.004	0.138	0.049	0.186	0.015	bd	0.002	210	125	18	96
	10:48 to 11:47	5	0.6	0.011	3.1	2.7	0.4	0.005	0.066	0.042	0.107	0.008	bd	0.001	157	96	12	33
	11:54 to 12:53	3	0.4	0.018	2.9	2.6	0.3	0.002	0.037	0.029	0.065	0.007	bd	bd	99	66	9	16
	12:58 to 13:58	1	0.4	0.021	2.7	2.4	0.2	0.002	0.029	0.029	0.057	0.008	bd	bd	118	73	9	18

Notes:

ppm - parts per million **ng/m^3** = nanograms per cubic meter **$\mu g/m^3$** = micrograms per cubic meter

bd - below detection limit of analyzer

Table A5: Median one-hour concentrations in Alberta

Station or Survey Type	Air Quality Station or Survey Name	Monitoring Period	CO ppm	O_3 ppm	THC ppm	CH_4 ppm	RHC ppm	SO_2 ppm	NO_2 ppm	NH_3 ppm	TRS ppm	H_2S ppm	TSP $\mu g/m^3$	PM_{10} $\mu g/m^3$	$PM_{2.5}$ $\mu g/m^3$	PAH ng/m^3
mobile	Calder Yards[1] (Current study)	Feb, Sept, Aug 2004 & Feb, Mar 2005	0.7	0.010	2.7	2.5	0.3	0.002	0.033	0.008	0.001	0.001	43	28	4	20
	Caroline[1]	Oct 05 & Jan, May, Jun 06	0.2	0.038	1.8	1.8	bd	0.002	0.004	0.003	0.001	0.001	79	49	6	1
	Girouxville (spring 2006)[1]	April 27-28, 2006	0.3	0.045	2.1	2.1	bd	0.001	0.002	0.095	0.002	0.001	149	82	8	1
	Girouxville (spring 2005)[1]	June14 and 15, 2005	0.4	0.027	1.9	1.9	bd	0.002	0.001	0.012	0.001	0.001	21	15	2	bd
	Girouxville (fall 2004)[1]	29 Nov -1 Dec, 2004	0.2	0.027	2.2	2.1	bd	0.001	0.001	0.009	0.001	bd	14	8	1	bd
	Whitecourt[1]	Sep. 6 - 7, 2005	0.2	0.027	2.1	2.1	bd	0.001	0.002	0.084	0.001	0.001	28	16	2	1
	Lloydminster[1]	Jan. 2002 to Nov. 2004	0.2	0.030	2.5	2.2	0.2	0.001	0.006	0.001	0.001	bd	19	13	2	3
	Lakeland Area[1]	May 2003 to Sep. 2004	0.2	0.031	2.6	2.4	0.2	bd	0.002	0.002	bd	bd	14	9	1	bd
	Banff[1]	Nov. 19 - 23, 2003	0.5	0.018	2.7	2.5	0.2	bd	0.008	0.004	bd	0.001	7	5	1	11
	Fort Saskatchewan/Redwater[1]	May 2001 to Mar. 2002	0.3	0.029	2.1	2.1	0.1	0.001	0.004	0.001	bd	bd	39	22	3	bd
	Cold Lake/Bonnyville/Elk Point[1]	Mar. 2001 to Feb. 2002	0.2	0.031	2.1	1.9	0.1	bd	0.003	0.000	0.001	bd	16	10	2	1
	Whitecourt/Swan Hills/Shiningbank Lake[1]	Mar. 2001 to Jun. 2001	0.2	0.027	2.3	2.0	0.3	0.004	0.005	0.001	0.001	bd	47	29	4	1
	Wabumun[1]	Jul. 2000 to Sep. 2001	0.2	0.027	2.0	1.9	0.1	0.002	0.005	0.004	bd	bd	34	22	3	1
	Edmonton Whitemud Drive[1]	Jun. 2000 to Jul. 2001	0.4	0.019	2.2	2.0	0.1	0.002	0.014	bd	bd	bd	41	24	3	8
Permanent Continuous Monitoring Stations																
urban	Calgary Central[2]	Jan. 2005 to Dec. 2005	0.4	0.014	2.0	n/a	n/a	n/a	0.022	n/a	n/a	n/a	n/a	19	4	n/a
	Edmonton Central[2]	Jan. 2005 to Dec. 2005	0.4	0.015	2.0	n/a	n/a	n/a	0.019	n/a	n/a	n/a	n/a	n/a	4	n/a
small urban	Fort Saskatchewan[2]	Jan. 2005 to Dec. 2005	0.2	0.02	1.9	n/a	n/a	0.001	0.008	0.001	n/a	bd	n/a	n/a	3	n/a
	Red Deer[2]	Jan. 2005 to Dec. 2005	0.2	0.02	2.0	n/a	n/a	bd	0.01	n/a	n/a	bd	n/a	n/a	3	n/a
rural	Beaverlodge[2]	Jan. 2005 to Dec. 2005	n/a	0.028	n/a	n/a	n/a	bd	0.003	n/a	n/a	n/a	n/a	n/a	2	n/a
	Fort Chipewyan[3]	Jan. 2005 to Dec. 2005	n/a	0.026	n/a	n/a	n/a	bd	bd	n/a	n/a	n/a	n/a	n/a	1	n/a
industrial	Buffalo Viewpoint[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.9	n/a	n/a	bd	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a
	Mannix[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.9	n/a	n/a	0.001	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a
	Mildred Lake[3]	Jan. 2005 to Dec. 2005	n/a	n/a	1.8	n/a	n/a	bd	n/a	n/a	n/a	bd	n/a	n/a	n/a	n/a

Notes:

bd – below detection limit

ppm - parts per million **ng/m^3** = nanograms per cubic meter **$\mu g/m^3$** = micrograms per cubic meter **n/a** – Parameter not monitored or data not available.

1 – Mobile survey conducted by Alberta Environment.
2 – Station operated by Alberta Environment.
3 – Station operated by the Wood Buffalo Environmental Association.
4 – Station operated by the West Central Airshed Society.
5 – Station operated by the Strathcona Industrial Association.
6 – Station operated by the Parkland Airshed Management Association.

Table A6: Meteorological conditions and operator's comments

Date	Times	Site	Comments	Temp C	RH %RH	WSP KPH	WDR DEG
11-Feb-04	08:23 to 09:23	1	Continuous traffic on 127 ave intermittent traffic on 117 st	-15.0	78.6	8.1	SW
	09:27 to 10:30	2		-12.6	72.6	9.0	SW
	10:35 to 11:48	3		-9.0	60.5	6.6	SSW
	11:58 to 12:58	4	No exceptional activity in Calder Yard	-5.8	55.0	11.2	SSW
	13:08 to 14:12	5		-3.3	51.7	10.7	S
	14:18 to 15:19	3		-2.2	53.2	10.7	SSW
	15:24 to 16:23	1		-1.4	54.6	11.1	SW
	16:38 to 17:37	5		-3.1	64.0	5.5	SW
	17:42 to 18:41	2		-3.3	67.4	5.5	SW
13-Feb-04	07:43 to 08:44	2	Good visibility	-4.7	91.3	6.5	ENE
	08:50 to 09:50	4	Normal traffic on Yellowhead	-4.1	88.8	8.4	ENE
	09:53 to 10:53	4a		-3.3	84.4	10.0	ENE
	11:09 to 12:09	6	Engine shuttling back and forth at times	-3.4	83.8	12.0	E
	12:13 to 13:13	6a	Along fence line at edge of yard	-3.6	80.3	9.6	E
	13:13 to 14:13	6a	Diesel shop immediately east of site	-3.7	76.3	8.1	E
	14:20 to 15:20	6	Wind picks up	-4.4	75.7	14.2	ENE
24-Feb-04	14:23 to 15:23	5	Hazy conditions city wide AQI is 40	0.1	70.0	5.8	E
	15:31 to 16:32	6	Some yard activity, still generally hazy	0.7	69.8	7.4	ENE
	16:46 to 17:47	3	Upwind site	-1.3	76.6	8.5	E
	17:52 to 18:52	6a	Hazy all over, not just Calder vicinity	-3.2	85.2	3.9	E
	18:52 to 19:51	6a	Wind coming right from diesel shops	-4.2	87.8	2.7	E
	20:06 to 21:06	6	Occasional train traffic	-4.7	88.6	4.3	ENE
	21:06 to 22:06	6	Occasional train traffic	-5.3	91.6	4.9	E
	22:07 to 22:35	6	1/2 hr average	-6.0	92.9	4.3	E
31-Aug-04	06:35 to 07:35	1	Normal traffic on 127 ave.	14.3	89.4	10.6	SE
	07:38 to 08:39	5		15.2	84.7	7.7	SE
	08:43 to 09:44	6		15.8	81.9	10.8	SSE
	09:51 to 10:52	4a		17.2	76.5	10.1	SSE
	10:57 to 11:57	1		18.9	70.9	10.1	SSE
	12:00 to 12:59	5		20.1	66.5	6.2	SSE
	13:04 to 14:03	6	No engines idling, several engines drive by	23.1	57.4	5.1	S
	14:14 to 15:14	4a	Constant traffic on Yellowhead	26.4	45.5	5.1	SSE
28-Sep-04	08:22 to 09:24	5		17.0	48.4	4.1	W
	09:30 to 10:31	1	Wind shifts to NW	17.5	44.7	5.1	WNW
	10:45 to 11:45	4	Downwind site	20.3	33.2	11.9	WNW
	11:47 to 12:48	4a	Downwind site	20.9	32.0	11.9	W
	12:49 to 13:49	4	Downwind site	19.9	33.6	17.1	NW
	13:57 to 14:56	7	Stopped at Edmonton Northwest site	21.4	29.1	11.2	NW

Continued ...

Table A6: Meteorological conditions and operator's comments continued from the previous page

Date	Times	Site	Comments	Temp C	RH %RH	WSP KPH	WDR DEG
25-Feb-05	06:09 to 07:09	2	Train engines idling 1 block to the west	-7.6	72.6	6.6	WSW
	07:15 to 08:20	1	Normal steady rush hour traffic on 121 ave.	-7.4	72.6	4.6	SW
	08:22 to 09:23	5		-4.4	59.8	4.9	W
	09:28 to 10:40	7	Stop at Edmonton Northwest site	1.6	41.6	4.2	SSW
	10:48 to 11:47	4	Clear sky	6.5	32.9	3.8	SSW
	11:54 to 12:53	5	Clear sky	9.6	25.9	5.5	W
	12:58 to 13:57	2	Some haze evident	11.4	24.3	6.1	WSW
1-Mar-05	06:17 to 07:18	1	Clear sky	-6.3	83.3	4.3	SSW
	07:27 to 08:27	5	Clear sky	-5.5	78.6	4.7	SSW
	08:33 to 09:33	3	Some haze is evident	-3.5	70.3	7.4	SSW
	09:44 to 11:01	4		4.2	43.5	4.3	SW
	11:08 to 12:09	1	Wind is now westerly	5.7	40.4	4.9	SSW
	12:12 to 13:13	4	Hazy conditions	7.1	36.8	6.6	S
2-Mar-05	06:13 to 07:17	1	Clear sky	-2.9	79.6	3.9	WSW
	07:21 to 08:20	3	Clear sky	-2.5	76.1	6.6	SW
	08:30 to 09:29	2	Continuous traffic on 121 ave.	0.2	66.7	5.1	SW
	09:41 to 10:40	4	Trains regularly moving by	5.3	50.5	5.2	SW
	10:48 to 11:47	5	Increased SO2 levels at this location some diesel exhaust odour evident	8.8	39.3	5.1	SSW
	11:54 to 12:53	3		8.8	42.2	6.9	S
	12:58 to 13:58	1		11.9	33.2	6.4	WSW

NOTES:
Temp - Temperature in degrees centigrade **RH** - Relative humidity in percentage **WSP KPH** – Wind speed in Km/hr
WDR DEG – Wind direction in degrees

Appendix B

The median concentration

The median concentration is a common way of representing the central value for environmental data. Most environmental data usually consist of a distribution that is skewed to the right; that is most data values are low and only a few are high. For such data sets, the arithmetic mean will be biased by the high concentrations; the resulting value may not be representative of the central value for the data set. For example, a data distribution consisting of five numbers: 1, 2, 2, 3 and 10. The arithmetic mean of these data is 3.6 and the median is 2. In this case, the arithmetic mean is biased high by the extreme value of 10. The median is the middlemost value in the data set; thus more representative of the central value of the data distribution. Fifty percent of the values in the dataset are below the median and fifty percent are above.

Alberta's Ambient Air Quality Objectives

Alberta's Ambient Air Quality Objectives[1] are established under Section 14 of the Environmental Protection and Enhancement Act (EPEA , R.S.A. 2000, c.E-12, as amended). EPEA provides for the development of environmental objectives for Alberta.
The Ambient Air Quality Objectives are used for:

- Reporting on the state of the atmospheric environment in Alberta.
- Reporting to Albertans on the quality of the air through Alberta's Air Quality Index (AQI).
- Establishing approval conditions for regulated industrial facilities.
- Evaluating proposals to construct facilities that will have air emissions.
- Guiding special ambient air quality surveys.
- Assessing compliance near major industrial air emission sources.

Some of Alberta's Ambient Air Quality Objectives are based on odour perception. This is the case for ammonia, nitrogen dioxide and hydrogen sulphide. For these chemicals, people are likely to detect an odour at concentrations well below levels that may affect human health. Alberta's Ambient Air Quality Objectives for one-hour average concentration of pollutants monitored by the MAML are listed in Table B1.

Table B1: Alberta's Ambient Air Quality Objective measured by the MAML

Pollutant	One-hour AAAQO (ppm)	Basis for Objective
Ammonia	2	odour perception
Carbon monoxide	13	oxygen carrying capacity of blood
Nitrogen dioxide	0.212	odour perception
Ozone	0.082	reduction of lung function and effects on vegetation
Hydrogen sulphide	0.01	odour perception
Sulphur dioxide	0.172	pulmonary function

ppm - parts per billion

[1] *Alberta Ambient Air Quality Objectives.* Alberta Environment. April 2005.

The Mobile Air Monitoring Laboratory (MAML)

The MAML is a 27-foot (8.2 m) vehicle that has been specially designed and equipped to measure air quality. It houses a variety of instruments that continuously sample the air at specified time or distance intervals. The MAML is equipped with:

- a dual computer system custom-programmed to accept and record the measurement of air samples from each analyser,
- a GPS (Global Positioning System) that identifies the MAML's location as it moves around Alberta,
- an exhaust purifying system that minimizes emissions from the vehicle and
- two on-board generators that are also equipped with exhaust scrubbers

Table B2 lists the pollutants and meteorological data monitored by the MAML. Also indicated are the lower and upper detection limits for each monitored species.

Figure B1: Alberta Environment's Mobile Air Monitoring Laboratory

Table B2: Pollutants and meteorological data monitoring by the MAML.

Pollutant	Operating Range	
	Lower Detection Limit*	**Upper Detection Limit****
Ammonia (**NH_3**)	0.001 ppm	5 ppm
Ozone (**O_3**)	0.001 ppm	0.5 ppm
Carbon Monoxide (**CO**)	0.1 ppm	50 ppm
Hydrocarbons		
Methane (**CH_4**)	0.1 ppm	20 ppm
Reactive Hydrocarbons (**RHC**)	0.1 ppm	20 ppm
Total Hydrocarbons (**THC**)	0.1 ppm	20 ppm
Polycyclic Aromatic Hydrocarbons (**PAH**)	3 ng/m^3	1000 ng/m^3
Oxides of nitrogen		
Nitrogen dioxide (**NO_2**)	0.0006 ppm	1 ppm
Nitric Oxide (**NO**)	0.0006 ppm	1 ppm
Oxides of nitrogen (**NO_x**)	0.0006 ppm	1 ppm
Particulate Matter		
Total Suspended Particulates (**TSP**)	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <10µm (**PM_{10}**)	1 $\mu g/m^3$	1.0 g/m^3
Particulate Matter <2.5µm (**$PM_{2.5}$**)	1 $\mu g/m^3$	1.0 g/m^3
Sulphur Compounds		
Hydrogen Sulphide (**H_2S**)	0.001 ppm	1 ppm
Total Reduced Sulphur (**TRS**)	0.001 ppm	1 ppm
Sulphur Dioxide (**SO_2**)	0.001 ppm	2 ppm
Meteorological data		
Wind Speed	0 km/hr	200 km/hr
Wind Direction	0 degrees	360 degrees
Temperature	-40 °C	50 °C
Relative humidity	0%	100%

ppm - parts per million

ng/m^3 = nanograms per cubic meter

$\mu g/m^3$ = micrograms per cubic meter

g/m^3 = grams per cubic meter

* The ***lower detection limit*** indicates the *minimum* amount of pollutant and the lower limit of meteorological data can be measured by the instrument.

** The ***upper detection limit*** indicates the *maximum* amount of pollutant the instrument can detect and the upper limit for meteorological data measured. This limit is set to provide the optimum precision over that range. The upper limit can be raised, however, precision at the lower levels (where most levels are monitored) is then compromised.